Modified Scintillation Detectors to Improve Slim-Hole Gamma Ray Log Repeatability in Low Radioactivity Materials

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Slim-hole gamma ray tools commonly use 1" × 4" or smaller sodium iodide (NaI) scintillation crystal detectors. This tool design was originally developed and is best suited for highly radioactive environments such as those associated with radioactive mineral exploration, and more recently in sediments contaminated with radionuclides.

The Lawrence Livermore National Laboratory (LLNL) Environmental Restoration Program relies heavily on interpretations of subsurface geology based on borehole core descriptions and wireline geophysical measurements, including gamma ray logs. Interborehole correlation of sands and clays are used to: (1) develop detailed three-dimensional high permeability subsurface channel models to predict fluid movement, (2) aid in locating boreholes, and (3) improve remediation performance.

Tertiary and Quaternary sediments of the Livermore Valley are derived from two separate source rock suites, both of which are very low in radioactive minerals. Thus, the resulting sediments show minimal sand/clay gamma ray contrasts. Conventional 1" × 4" or smaller NaI scintillation crystal detectors generate inadequate counting statistics to provide reliable sand/clay discrimination and/or stratigraphic correlation. The result is highly unstable detector count rates and poor log repeat sections.

Slim-hole natural gamma ray log detector stability and log repeatability at the LLNL Livermore Site has been significantly improved using slim-hole gamma ray logging tools with 1" × 8" NaI scintillation crystal detectors. The increased count rate stability achieved by doubling the detector crystal volume has greatly exceeded that achieved from extending the counting time windows and/or reducing the logging speed when using the smaller crystal. This LLNL Livermore Site experience in improving slim-hole gamma ray log reliability should be valuable in other areas with low radioactivity count rates.

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